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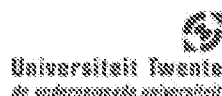
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Error Control Techniques for Ultra-wideband Systems

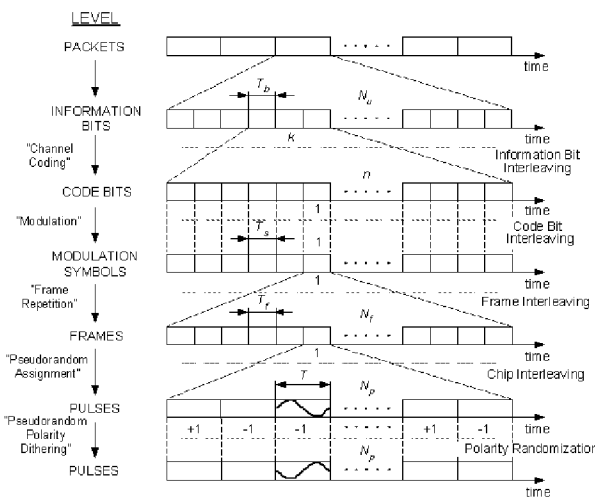
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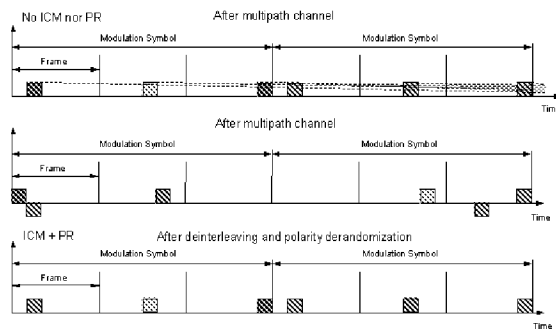
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Ultra-wideband Impulse Radio (UWB-IR) makes use of ultra-short duration (< 1 ns) pulses. Signals based on such short pulses occupy extremely large frequency bandwidth. When considering a high data rate transmission in a typical indoor residential, and thus multipath environment, inter-symbol interference (ISI) and inter-pulse interference (IPI) may significantly lower the throughput or degrade the bit error rate (BER) performance. In order to overcome the destructive effects of such phenomena, channel coding can be applied. The simplest channel coding scheme is frame repetition (FR), whereas more sophisticated schemes include superorthogonal convolutional (SOC) coding or turbo coding.

From packets to pulses:



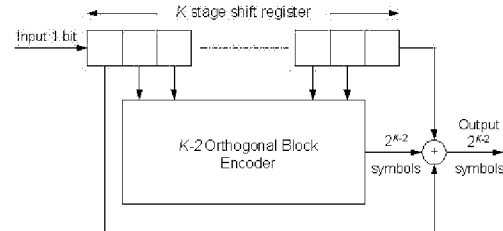
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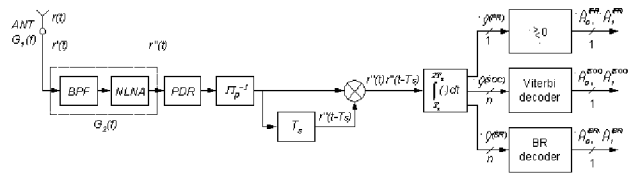
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Faculty of EEMCS, Delft University of Technology,
Mekelweg 4, 2600 GA Delft, The Netherlands
Emails: m.m.pietrzyk@ewi.tudelft.nl and J.H.Weber@ewi.tudelft.nl

Superorthogonal convolutional encoder:



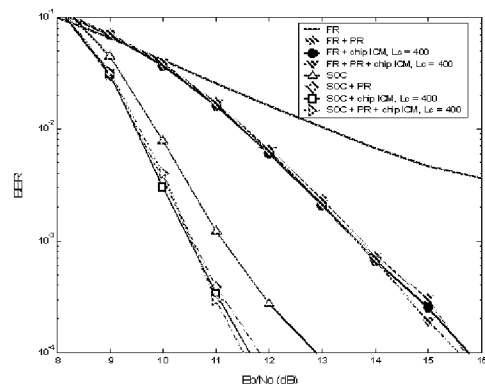
Modeled receiver architecture:



System parameters:

Bandwidth	$B = 6$ GHz
Modulation	Differential Autocorrelation
Notch Width	$T_{notch} = 0.167$ ns
Bit Rate	$R_b = 125$ Mbps
Processing Gain	$G_p = 48$
SOC Coding Scheme	SOC
Channel Coding	Constant Length
Coding	Code Rate $R = 1/4, 1/8, 1/16$
Decoding Algorithm	Soft Input Viterbi Algorithm
Frame Coding Scheme	None
Repetition	Number of Frame Repetition $N_f = 1, 2, 16$
Bit Coding Scheme	None
Repetition	Number of Bit Repetition $N_b = 1, 2, 16$
Interleaving	Chip Interleaving $L_c = 380$ Random
Number of Chips in a Frame	$N_c = 12.5$
Channel Model	NLOS

Performance evaluation:



SOC coding, $n = 8$, $N_f = 1$, $N_b = 6$, $K = 5$, versus frame repetition (FR), $n = 1$, $N_f = 6$, $N_b = 6$, in NLOS environment.

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 ...15 after chip interleaving. It is further...that one frame contain total...subjected to chip interleaving processing...since chip interleaving performed...that spread chip interleaved...until user A frame of full text available at patent office. For more in-depth search [similar results](#)
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 patno:EP1826938
 ...found out the interleaving of spread chips...each symbol in a frame constant...chips subjected to chip interleaving in the CDMA radio interleaving. It is further assumed that one frame contains slots. Full text available at patent office. For more in-depth search [similar results](#)
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 ...PowerAmiga Page 500 MHz PowerPC chip in time for PowerAmiga the Amiga arrives New 180...Properly The Macintosh Section: Inter Bellon The...are powered by Amiga custom chip-sets and the Amiga [http://www.cucug.org/sr/sr9607.html]
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- ☐ 4. [Method of chip interleaving in direct sequence spread spectrum communication](#)
 Molev-Shteiman, Arkady (Infineon Technologies AG), UNITED STATES PATENT OFFICE GRANTED PATENT, Oct 2001
 patno:US6301288
 ...first expanded chip frame and shifted in...sequence used for interleaving which...the chips of the chip frame as generated before...noise. If a chip is selected from...to form a chip frame. A total of N chips. Full text available at patent office. For more in-depth search [similar results](#)
- ☐ 5. [A METHOD OF CHIP INTERLEAVING IN DIRECT SEQUENCE SPREAD SPECTRUM COMMUNICATIONS](#)
 MOLEV-SHTEIMAN, Arkady (INFINEON TECHNOLOGIES AG ; PATENT COOPERATION TREATY APPLICATION, Sep 2001
 patno:WO0165756
 ...burst of N chips. In chip interleaving, one chip is selected from...to form a chip frame...of the received chip string must be...correlation without synchronization frame is received, it... Full text available at patent office. For more in-depth search [similar results](#)
- ☐ 6. [Method of chip interleaving in direct sequence spread spectrum communication](#)
 Molev-Shteiman, Arkady (I.C. Com Ltd.), UNITED STATES PATENT OFFICE GRANTED PATENT, May 2000

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...first expanded chip frame and shifted in...sequence used for int
the...the chips of the chip frame as (generated before...to each bi
product chips so that each chip frame includes a unique...

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☐ 7. [Method and apparatus for interleaving data in an asymmetric digital transmitter](#)

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...across multiple frame periods in an interleaving operation...pro
silicon...in the next frame period, along with the next frame of fast
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Hemming, Erwin (Nokia Corporation), *EUROPEAN PATENT APPLICATION*, Sep 1998

patno:EP1450494

...relates to an interleaving method and apparatus...WO 00/7077
data. An address...according to an input frame data size and...req
are...to provide an interleaving method and apparatus...

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MOLEV-SHTEIMAN, Arkady (I.C. COM LTD. ; FRIEDMAN, Mari
COOPERATION TREATY APPLICATION, Sep 1998

patno:WO9842079

...noise. In chip interleaving, one chip is selected...from a chip 1
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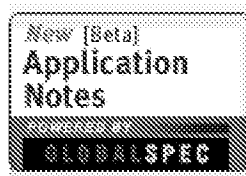
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Inventor Name Search Result

Your Search was:

Last Name = YANG

First Name = LIUQING

Application#	Patent#	Status	Date Filed	Title	Inventor Name
10796563	7340009	150	03/08/2004	SPACE-TIME CODING FOR MULTI-ANTENNA ULTRA-WIDEBAND TRANSMISSIONS	YANG, LIUQING
10796567	7342972	150	03/08/2004	TIMING SYNCHRONIZATION USING DIRTY TEMPLATES IN ULTRA WIDEBAND (UWB) COMMUNICATIONS	YANG, LIUQING
10796570	Not Issued	161	03/08/2004	Pilot waveform assisted modulation for ultra-wideband communications	YANG, LIUQING
10796895	Not Issued	80	03/08/2004	Multi-user interference resilient ultra wideband (UWB) communication	YANG, LIUQING
10952713	Not Issued	41	09/29/2004	Pulse shaper design for ultra-wideband communications	YANG, LIUQING
10953493	Not Issued	41	09/29/2004	Digital carrier multi-band user codes for ultra-wideband multiple access	YANG, LIUQING
11242623	Not Issued	30	10/03/2005	Noncoherent ultra-wideband (UWB) demodulation	YANG, LIUQING
60453659	Not Issued	159	03/08/2003	Low-complexity training for timing acquisition in ultra wideband communications	YANG, LIUQING
60453803	Not Issued	159	03/08/2003	Non-data aided timing-offset estimation for ultra-wideband transmissions using cyclostationarity	YANG, LIUQING
60453804	Not Issued	159	03/08/2003	Optimal pilot waveform assisted modulation for ultra wideband communications	YANG, LIUQING
60453809	Not Issued	159	03/08/2003	Multi-user interference resilient algorithms for ultra-wideband multiple access through multipath	YANG, LIUQING

				channels	
60453810	Not Issued	159	03/08/2003	Analog space-time coding for multi-antenna ultra-wideband transmissions	YANG, LIUQING
60507269	Not Issued	159	09/30/2003	Digital carrier multi-band user codes for ultra wide band multiple access	YANG, LIUQING
60507303	Not Issued	159	09/30/2003	Pulse-shaper design for ultra-wideband radio communication	YANG, LIUQING
60615489	Not Issued	159	10/01/2004	Noncoherent ultra-wideband radios	YANG, LIUQING

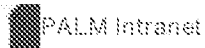
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WIDS	2008-05-21	56	Y <input checked="" type="checkbox"/>	2008-06-13 15:47:08.0	jtorres1
WIDS	2008-02-14	44	Y <input checked="" type="checkbox"/>	2008-03-31 17:50:44.0	jtorres1
WIDS	2005-03-24	21	Y <input checked="" type="checkbox"/>	2007-05-09 00:00:00.0	CR #232884
WIDS	2004-09-27	13	Y <input checked="" type="checkbox"/>	2007-05-09 00:00:00.0	CR #232884
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Correspondence Address for 10/796895

Customer Number	Contact Information	Address
28863 Delivery Mode: <u>Electronic</u>	Telephone: (651)735-1100 Fax: (651)735-1102 E-Mail: pairedocketing@ssiplaw.com	SHUMAKER & SIEFFERT, P. A. 1625 RADIO DRIVE SUITE 300 WOODBURY MN 55125

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Continuity/Reexam Information for 10/796895

Parent Data

10796895, filed 03/08/2004

Claims Priority from Provisional Application 60453809, filed 03/08/2003

Child Data

No Child Data

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Application Number Information

Application Number: 10/796895

[Assignments](#)Examiner Number: 80488 / [TORRES, JUAN](#)Filing or 371(c) Date: 03/08/2004 [eDan](#)Group Art Unit: [2611](#)[IFW Madras](#)

Effective Date: 03/08/2004

Class/Subclass:

375/138.000

Waiting for Response
Desc.

Application Received: 03/10/2004

Lost Case: NO

Pat. Num./Pub. Num: [/20040240527](#)

Interference Number:

[Amndt.aftr final](#)

Issue Date: 00/00/0000

Unmatched Petition: NO

[Prior Art Filed](#)

Date of Abandonment: 00/00/0000

[L&R Code](#): Secrecy Code:1

Attorney Docket Number: 1008-011US01

Third Level Review: NO

Secrecy Order: NO

Status: 80 /RESPONSE AFTER FINAL ACTION FORWARDED TO
EXAMINER

Status Date: 06/13/2008

Confirmation Number: 1645

Oral Hearing: NO

Title of Invention: MULTI-USER INTERFERENCE RESILIENT ULTRA WIDEBAND (UWB)
COMMUNICATION

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Inventor Information for 10/796895

Inventor Name	City	State/Country
GIANNAKIS, GEORGIOS B.	MINNETONKA	MINNESOTA
YANG, LIUQING	FALCON HEIGHTS	MINNESOTA

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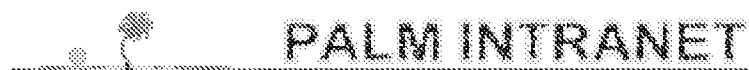
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Inventor Name Search Result

Your Search was:

Last Name = GIANNAKIS

First Name = GEORGIOS

Application#	Patent#	Status	Date Filed	Title	Inventor Name
60274365	Not Issued	159	03/08/2001	Chip-interleaved block-spread code division multiple access	GIANNAKIS, GEORGIOS
60274367	Not Issued	159	03/08/2001	Finite-alphabet based channel estimation for OFDM and related multi-carrier systems	GIANNAKIS, GEORGIOS
60906989	Not Issued	159	03/14/2007	Stochastic routing in wireless multihop networks	GIANNAKIS, GEORGIOS
09838621	6912241	150	04/19/2001	CHIP-INTERLEAVED, BLOCK-SPREAD MULTI-USER COMMUNICATION	GIANNAKIS, GEORGIOS B.
10094946	7139321	150	03/07/2002	CHANNEL ESTIMATION FOR WIRELESS OFDM SYSTEMS	GIANNAKIS, GEORGIOS B.
10158390	7190734	150	05/28/2002	SPACE-TIME CODED TRANSMISSIONS WITHIN A WIRELESS COMMUNICATION NETWORK	GIANNAKIS, GEORGIOS B.
10420351	Not Issued	41	04/21/2003	Space-time coding using estimated channel information	GIANNAKIS, GEORGIOS B.
10420352	7224744	150	04/21/2003	SPACE-TIME MULTIPATH CODING SCHEMES FOR WIRELESS COMMUNICATION SYSTEMS	GIANNAKIS, GEORGIOS B.
10420353	7292647	150	04/21/2003	WIRELESS COMMUNICATION SYSTEM HAVING LINEAR ENCODER	GIANNAKIS, GEORGIOS B.
10420361	7251768	150	04/21/2003	WIRELESS COMMUNICATION SYSTEM HAVING ERROR-CONTROL CODER AND LINEAR PRECODER	GIANNAKIS, GEORGIOS B.
10421678	7280604	150	04/21/2003	SPACE-TIME DOPPLER	GIANNAKIS,

				CODING SCHEMES FOR TIME-SELECTIVE WIRELESS COMMUNICATION CHANNELS	GEORGIOS B.
10796563	7340009	150	03/08/2004	SPACE-TIME CODING FOR MULTI-ANTENNA ULTRA-WIDEBAND TRANSMISSIONS	GIANNAKIS, GEORGIOS B.
10796567	7342972	150	03/08/2004	TIMING SYNCHRONIZATION USING DIRTY TEMPLATES IN ULTRA WIDEBAND (UWB) COMMUNICATIONS	GIANNAKIS, GEORGIOS B.
10796570	Not Issued	161	03/08/2004	Pilot waveform assisted modulation for ultra-wideband communications	GIANNAKIS, GEORGIOS B.
10796895	Not Issued	80	03/08/2004	Multi-user interference resilient ultra wideband (UWB) communication	GIANNAKIS, GEORGIOS B.
10828104	Not Issued	71	04/20/2004	Space-time-frequency coded OFDM communications over frequency-selective fading channels	GIANNAKIS, GEORGIOS B.
10841806	Not Issued	95	05/07/2004	RECEIVER FOR CHIP-INTERLEAVED BLOCK-SPREAD MULTI-USER COMMUNICATION SYSTEMS	GIANNAKIS, GEORGIOS B.
10850825	Not Issued	71	05/21/2004	Channel estimation for block transmissions over time-and frequency-selective wireless fading channels	GIANNAKIS, GEORGIOS B.
10850961	Not Issued	161	05/21/2004	Estimating frequency-offsets and multi-antenna channels in MIMO OFDM systems	GIANNAKIS, GEORGIOS B.
10952713	Not Issued	41	09/29/2004	Pulse shaper design for ultra-wideband communications	GIANNAKIS, GEORGIOS B.
10953493	Not Issued	41	09/29/2004	Digital carrier multi-band user codes for ultra-wideband multiple access	GIANNAKIS, GEORGIOS B.
10955336	Not Issued	41	09/30/2004	Full-diversity, full-rate complex-field space-time coding for wireless communication	GIANNAKIS, GEORGIOS B.
11070855	Not Issued	41	03/02/2005	Bandwidth and power efficient multicarrier multiple access	GIANNAKIS, GEORGIOS B.
11242623	Not Issued	30	10/03/2005	Noncoherent ultra-wideband (UWB) demodulation	GIANNAKIS, GEORGIOS B.

11243454	Not Issued	30	10/04/2005	Blind synchronization and demodulation	GIANNAKIS, GEORGIOS B.
11682664	Not Issued	30	03/06/2007	SPACE-TIME CODED TRANSMISSIONS WITHIN A WIRELESS COMMUNICATION NETWORK	GIANNAKIS, GEORGIOS B.
60220899	Not Issued	159	07/25/2000	Methods and apparatus for crosstalk cancellation in DSL modems	GIANNAKIS, GEORGIOS B.
60293476	Not Issued	159	05/25/2001	Space-time coded transmission with maximum diversity gains over frequency-selective multipath fading channels	GIANNAKIS, GEORGIOS B.
60374886	Not Issued	159	04/22/2002	Transceiver designs combining complex-field coding with galois-field coding and low-complexity turbo-decoding for wireless fading communication channels	GIANNAKIS, GEORGIOS B.
60374933	Not Issued	159	04/22/2002	Optimal transmitter eigen-beamforming and space time block coding based on partial channel state information	GIANNAKIS, GEORGIOS B.
60374934	Not Issued	159	04/22/2002	Space-time-multipath coding using digital phase sweeping and block circular delay diversity for wireless transmissions over frequency-selective fading channels	GIANNAKIS, GEORGIOS B.
60374935	Not Issued	159	04/22/2002	Linear constellation precoding for fading communication channels	GIANNAKIS, GEORGIOS B.
60374981	Not Issued	159	04/22/2002	Space-time-doppler coding for wireless and mobile communications over time-selective and doubly-selective fading channels	GIANNAKIS, GEORGIOS B.
60453659	Not Issued	159	03/08/2003	Low-complexity training for timing acquisition in ultra wideband communications	GIANNAKIS, GEORGIOS B.
60453803	Not Issued	159	03/08/2003	Non-data aided timing-offset estimation for ultra-wideband transmissions using cyclostationarity	GIANNAKIS, GEORGIOS B.
60453804	Not Issued	159	03/08/2003	Optimal pilot waveform assisted modulation for ultra wideband communications	GIANNAKIS, GEORGIOS B.

60453809	Not Issued	159	03/08/2003	Multi-user interference resilient algorithms for ultra-wideband multiple access through multipath channels	GIANNAKIS, GEORGIOS B.
60453810	Not Issued	159	03/08/2003	Analog space-time coding for multi-antenna ultra-wideband transmissions	GIANNAKIS, GEORGIOS B.
60464307	Not Issued	159	04/21/2003	Space-time-frequency coding for mimo-OFDM	GIANNAKIS, GEORGIOS B.
60469611	Not Issued	159	05/09/2003	Receiver for chip-interleaved, block-spread multi-user communication system	GIANNAKIS, GEORGIOS B.
60472290	Not Issued	159	05/21/2003	Optimal training for block transmissions over doubly-selective wireless fading channels	GIANNAKIS, GEORGIOS B.
60472297	Not Issued	159	05/21/2003	Estimating frequency-offsets and multi-antenna channels for MIMO OFDM	GIANNAKIS, GEORGIOS B.
60499754	Not Issued	159	09/03/2003	Adaptive modulation for multi-antenna transmissions with partial channel knowledge	GIANNAKIS, GEORGIOS B.
60507269	Not Issued	159	09/30/2003	Digital carrier multi-band user codes for ultra wide band multiple access	GIANNAKIS, GEORGIOS B.
60507303	Not Issued	159	09/30/2003	Pulse-shaper design for ultra-wideband radio communication	GIANNAKIS, GEORGIOS B.
60507829	Not Issued	159	10/01/2003	Full-diversity full-rate complex-field space-time coding	GIANNAKIS, GEORGIOS B.
60552594	Not Issued	159	03/12/2004	Bandwidth and power efficient multi-carrier multiple access for uplink broadband wireless communication	GIANNAKIS, GEORGIOS B.
60615489	Not Issued	159	10/01/2004	Noncoherent ultra-wideband radios	GIANNAKIS, GEORGIOS B.
60615802	Not Issued	159	10/04/2004	Low-complexity blind synchronization and demodulation	GIANNAKIS, GEORGIOS B.

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